DOCUMENT RESUME

ED 443 844 TM 031 489

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TITLE Assessment in the Mathematics Curriculum.
PUB DATE 2000-00-00
NOTE 10p.
PUB TYPE Opinion Papers (120)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Criterion Referenced Tests; Evaluation Methods; *Mathematics Achievement; Norm Referenced Tests; Performance Based Assessment; *Portfolio Assessment; *Standardized Tests; *Student Evaluation

ABSTRACT

The assessment of student achievement in mathematics is discussed. Different approaches should be used to ascertain student achievement of objectives in the mathematics curriculum. Some methods are subjective, such as rating scales, and these can be very useful. Among more objective approaches is the use of standardized tests. There is a number of disadvantages to the use of standardized tests, especially in the distance of the test developer from the student. Criterion referenced tests contain objectives that teachers may use as guidance for instruction. Portfolios are another approach to mathematics assessment. Though they have many advantages over standardized norm-referenced tests and criterion referenced tests, they have their own disadvantages in scoring difficulties and difficulties of interpretation. It may be that both standardized testing and portfolio assessment should be used to gain a better picture of student achievement in mathematics. (SLD)

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ED 443 844

Assessment in the Mathematics Curriculum

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ASSESSMENT IN THE MATHEMATICS CURRICULUM

Assessment of learner achievement has become a key item in speeches given and journal articles written pertaining to students documented growth in different curriculum areas. This manuscript will deal with documenting student achievement in mathematics. Why is it important to document student achievement and growth in mathematics?

1. the business world and the lay public desire objective results from learner progress in school.
2. accountability is stressed often in order to hold a teacher or teaching team responsible for a specific class of students' achievement and progress.
3. research is more likely to be done to improve mathematics teaching if objective data is available such as test results in which numerical data may be used for experimental and correlational studies.
4. teachers have an objective basis in using documented information to make decisions pertaining to objectives, learning opportunities, and evaluation techniques to use in teaching and learning situations.
5. improved sequence in student learning may accrue with the use of quantitative assessment information (Ediger, 1994, 169-174).

Subjective Methods of Assessment

Should subjective methods of assessing student achievement in mathematics be eliminated or minimized? Different approaches should be used to ascertain student achievement of objectives in the mathematics curriculum. There are selected subjective methods that might provide valuable information on student progress. Rating scales, as one approach, may be used at selected intervals. Here, the teacher devises a list of goals for students to achieve. For a daily lesson plan, perhaps, one or two goals can be stressed only, due to student interest factors and time in the day schedule of classes. In supervising student teachers and cooperating teachers, the writer has collected rating scales that teachers devised and used to rate students on a five point scale. The following behaviors were listed in mathematics for a week of lessons taught:

1. understands the commutative property of multiplication.
2. accurately multiplies two digit factors.
3. uses manipulative materials to obtain or verify an answer.
4. shows interest in ongoing lessons in mathematics.
5. is willing to assist other students, when necessary.

From the above five enumerated items, number two can be measured rather readily. Item # 2, is precise in terms of stating what is wanted from students to indicate mastery. Rating is not possible, but is better used in a checklist to be discussed later. The word "understands" in number one above is openended and lends itself to rating on a rating scale.Perhaps the words, "states orally what is meant by the commutative property of multiplication" makes clear what is wanted in terms of student learning. It might then be more appropriate to be a part of a checklist, due to it being an either/or objective for possible student achievement. Item #3 for student achievement would need to be observed if this is being done in degrees by the learner and can then be rated by the teacher. Item #4 is quite subjective to measure in terms of student achievement. Interests are within the learner and are a very important factor in learning. There are, however, ways to observe if the student truly is interested in and keeps learning in mathematics. A five point rating scale may be used by the teacher to assess student interest in mathematics. For #5 above, in degrees, the teacher may observe and rate if a learner helps students who need assistance in ongoing learning activities in mathematics.

Ratings given on a Lickert Scale do come on a continuum, such as from one to five. Each numerical category should have descriptions of when a one, two, three, four, or five rating is to be given. Thus for item #5, the following might be examples on a continuum of a student being willing to assist others in mathematics, using a five point scale of rating:

1. provides much accurate assistance to peers in ongoing lessons and units of study.
2. provides some help to peers when the need arises.
3. provides accurate, but reluctant help.
4. prefers not to be bothered by others needs in mathematics.
5. refuses to assist peers in all learning situations.

A first cousin of the rating scale is the checklist to evaluate student achievement in mathematics. Here, student behaviors are listed that will be stressed in ongoing lessons and units of study. A teacher may then place a check mark in front of a behavior that has been achieved. This provides a record for each student in terms of what has/has not been accomplished. The teacher needs to document attained objectives and not merely leave it to the mind or memory to recall important information about student achievement in mathematics. The following, as an example, are provided to notice what might be placed into a checklist:

1. the student divides accurately a four digit dividend by a one place divisor with no remainder in the quotient. If a student can do this as a result of teaching, a check mark is placed next to this behavior.
2. the student can check his/her answer correctly to the above division problem.

3. the student can explain thoroughly why the divisor times the quotient equals the dividend.

Those students who do not have a check mark in front of any numeral above will need more assistance the next school day in a mathematics lesson. The checklist, as well as the rating scale, has the student's name on it and the date of the lesson. The teacher then does not need to rely upon his/her memory only in ascertaining what a student needs sequentially to achieve as optimally as possible (See Ediger, 1995, 135-139).

Standardized Tests To Measure Achievement

Several states in the United States require using standardized tests to determine and report learner progress. Hopefully, the state will look for high validity and reliability figures when choosing which test to use to measure student achievement. It is difficult to align mathematics instruction in the classroom with content contained in any standardized achievement test. Why? There are no accompanying objectives for most standardized achievement test. Thus, the mathematics teacher has no benchmark to use as guidelines for teaching each lesson and unit in mathematics. Validity is then lacking since the local mathematics curriculum is not aligned with the test items on the standardized test. The Tenth Edition of The Mental Measurements Yearbook is a good source to use to notice what has been written by measurement specialists pertaining to any standardized test. The two important items of validity and reliability, among other information, are assessed for each common standardized test with numerical data presented. It is important for any committee member when making choices as to which standardized test to adopt to be highly cognizant of what makes for a quality test, by using the following criteria, among others:

1. does the test measure the mathematics curriculum objectives to the best it can be determined within the state or school district?
2. is the test easy and economical to administer?
3. are the norms of the test clear and meaningful to make comparisons of local student achievement?
4. does the test indicate how validity was ascertained?
5. how was reliability determined? Was it through alternative forms, split half, and/or test-retest?
6. will the test results truly indicate how well students are doing in mathematics achievement?
7. can the results communicate accurately to parents how well students are achieving?
8. will data be available from test results to show which areas students are weak in (diagnosis) and where their strengths are in

mathematics accomplishments?

9. will the results from testing lead to improved student achievement and progress in mathematics?

10. might quality sequence in mathematics be improved for each student? (See Ediger, 1997, Chapter Sixteen)

The above named questions are vital to ponder and reflect upon. Each student needs to achieve as optimally as possible in the mathematics curriculum. No student should fall through the cracks, but enjoy and use mathematics in a utilitarian way.

Disadvantages in using standardized tests to measure student achievement in mathematics are important to consider for any school system and state that mandates their use. The results from students taking these tests are not objective. For example, when the test items are written, there is considerable subjectivity in terms of which items to measure learner progress in. The writers could have chosen other test items than those which were included. Validity is difficult to determine since the test items cannot possibly be aligned with what each teacher has stressed in teaching and learning within a classroom. Thus, how validity was determined may be weakly stated in the manual of the standardized test. Reliability, or consistency of results, from students in test/retest, split half, and/or alternative forms can be determined somewhat more objectively with numerical results. However, reliability is not as important as compared to validity in that a test should measure what it purports to measure. Thus, students have had opportunities to learn that which is stated in the objectives in the local classroom.

Test writers are far removed from the local classroom where teaching and learning occur. They cannot be there to diagnose and remedy problems learners face in mathematics. Test writers do not know the local student in terms of what he/she can/cannot achieve in mathematics. Special provision then cannot be made for these students as individuals. Generally, little use can be made by the teacher of student results from a standard test. The results appear in terms of percentiles, grade equivalents, and/or standard deviations from the mean. The latter are more difficult to understand as compared to percentiles and grade equivalents, in particular. With a percentile from a student's test results, little is known specifically, for example, what can be done by the teacher to guide students to do better in computation or problem solving.

The mathematics teacher needs to be cognizant of the norms of the standardized test used. For example when viewing the manual of the test used on which it was standardized, the norms may have been developed on middle class students; then learners from lower socio-economic levels taking the standardized test may be penalized since

they do not come form middle class homes. Students from lower socio-economic levels have not had the opportunities to learn as compared to upper income homes. Very frequently, a critic of standardized testing states that these tests measure socio-economic levels rather than achievement. Or a test standardized on above average achievers may not indicate accurately where a local student is who does not have above average achievement.

However, standardized tests do

1. provide a global picture of how well students do in mathematics.
2. provide comparisons among school districts within a state which has administered that specific test.
3. make for report cards that indicate how well one district has achieved as compared to another district.
4. mass score huge numbers of tests with the use of machine scoring to reveal student progress quickly, even though the results may not reach the schools until a much later time.
5. make comparisons of one student with another with the use of percentiles. Printouts of student results from test taking may also indicate grade equivalents, stanines, normal curve equivalents, and mean/standard deviation comparisons of an individual student (See National Council Teachers of Mathematics, 1989).

Criterion Referenced Tests (CRTs)

CRTs have objectives as benchmarks for the teacher to use in teaching mathematics. There are corporations which produce CRTs. Generally, different states in the United States write their own CRTs. State produced CRTs do not have validity and reliability data, as do corporations which develop tests for profit, such as standardized tests. The latter's data is given in the specific test's manual being used or in the latest Mental Measurements Yearbook.

Objectives available for CRTs do provide teachers with some assurance that they may relate their teaching of content with items on the test. These objectives then may provide teachers with guidance and direction for instruction. Iowa is the only state in the United States that does not have a mandated test. Is that a good policy when a state does not mandate a test for students to take? Not necessarily. Teachers in these situations may feel more creative in choosing objectives, learning opportunities, and assessment procedures. They are not under the mass amount of pressure that teachers and students have in states where high stakes testing is involved or educational bankruptcy laws are in existence. The high expectations movement in education advocates "raising the bar" for student achievement. How high should the standards be? There is no way of knowing this. Quality, broad guidelines to use in decision making for teaching include the following:

1. have challenging but achievable objectives.
2. have interesting, purposeful, and meaningful learning opportunities.
3. have a variety of assessment techniques available to ascertain student achievement of quality objectives (See Ediger, 1994, 302-306).

The chosen objectives and subject matter in a CRT are subjective since human beings could have chosen other items for the test. The test results may be objective only if the same key is used for scoring all student's responses. Thus, objective scored results may provide data, such as percentile ranks for individual students.

Portfolio Use in Mathematics

Portfolios are developed in the local classroom by the student with teacher guidance. Thee is no input here from people rather far removed from the local classroom, such as test writers of standardized or CRTs. Products and processes selected to become a part of the portfolio are holistic, rather than isolated test items contained in the usual standardized or CRTs. Thus with portfolios, for example, an entire written product from a daily lesson may become inherent in a portfolio (See Columba and Dolgos, 1995). Additional differences between standardized tests and CRTs versus portfolios involve the following:

1. portfolios emphasize a contextual philosophy. The items for a portfolio come from ongoing learning activities and experiences, not test items separated from each other such as in a formalized measurement instrument.
2. they stress the actual work done by students in class instead of test results to determine what has been learned.
3. products and processes relate directly to the curriculum taught.
4. validity is high since the portfolio, as an evaluation device, should relate directly to the objectives emphasized in teaching and learning.
5. student input is there for portfolio development whereas in standardized and CRTs, there is no involvement by the learner in determining content items.
6. responsible individuals, such as parents, may evaluate their offspring's portfolio to notice achievement and ask questions about its contents.
7. teacher accountability is in the offing when portfolio information provides student progress reports in contextual form.
8. specific feedback of daily work is provided to teachers and the involved student when examining the ongoing and completed portfolio.
9. student pride and progress may be inherent when personal portfolios are being developed.

10. student deficiencies on a a daily basis may be noticed in daily learning and remedied within a specific learning situation (See Ediger, 1999, ERIC).

Portfolios do have selected advantages over standardized and CRTs, but they also face numerous criticisms, such as the following:

1. they are difficult to assess and cannot be machine scored.
2. two or more assessors need to appraise each portfolio to ascertain agreement upon the merits of each. If assessors are far apart on their individual evaluations, then reliability in scoring is lacking. The question then arises pertaining to the quality of the portfolio. If assessors use rubrics in the evaluation process, the ratings can become increasingly objective.
3. voluminous portfolios are very time consuming to assess as compared to machine scoring of standardized and CRTs.
4. the cost is high for assessment if qualified outsiders are to be employed to evaluate each portfolio.
5. if teachers are to assess the many portfolios in a school, the time given here may cut back on planning time for teaching.

There is a tradeoff involving standardized/norm referenced testing versus portfolio development. There are definite pros and cons for each approach. Perhaps, both procedures need to be used. Testing is a check on portfolio results and vice versa. A further problem then arises as to adequate time being provided for quality instruction. Thus, excessive time should not be given to testing and portfolio development. Students need ample time for challenging, achievable objectives in mathematics.

Varied learning opportunities to attain these objectives should be interesting, meaningful, and purposeful. Assessment techniques to ascertain learner achievement should be valid and reliable. Quality optimal sequence in learning should be an end result (See National Council Teachers of Mathematics, 1991).

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